

would be available for carbonising, oil and ammonia being removed from it by efficient scrubbing. The author was of opinion that nothing was known practically of what happens when coal is distilled, and that the coking of coals and manufacture of gas were now only empirical operations, and could not be conducted scientifically, with our present imperfect knowledge, but that the interests involved were so great, the subject being one of national importance, that failure to initiate and execute the necessary systematic experiments without further loss of time would be inexcusable.

On the last day of the meeting Mr. Carnegie's paper on "Natural Gas Fuel and its Application to Manufacturing Purposes" was read. This fuel is found in the Pittsburg district, and one of the wells is estimated as yielding 30,000,000 cubic feet of gas in the twenty-four hours; the pressure of the gas as it issues from the mouth of the well is about 200 lbs. to the square inch, and even at the works, nine miles from the wells, it is 75 lbs. per square inch. Eleven lines of pipe convey the gas from the various wells to the manufacturing establishments in and around Pittsburg. The number of men whose labour will be dispensed with when gas is generally used is 5000. In the steel-rail mills, for instance, where before would have been seen thirty stokers, stripped to the waist, firing boilers which require a supply of about 400 tons of coal in twenty-four hours—ninety firemen in all being employed, each working eight hours—there would now be found one man walking around the boiler-house, simply watching the water-gauges, and not a particle of smoke is to be seen.

Dr. Hermann Wedding's paper on "The Properties of Malleable Iron deduced from its Microscopic Structure" draws attention to the value of microscopic analysis, as, though the chemical and physical properties of iron are closely connected, the one cannot be directly deduced from a knowledge of the other, nor do either of these aid in acquiring a knowledge of the mechanical properties. The pieces of iron to be tested are carefully polished, and then etched with very dilute nitric acid. After etching, the section is carefully heated, whereupon the portions attacked acquire varying tints, mostly golden-yellow, purple-red, violet, or dark blue. It is the difference of colour that is characteristic. As regards the formation of grains and fibres, the size of grain increases with slowness of cooling, and decreases with increase in the proportion of carbon up to 2 per cent. Each individual grain in malleable iron is ductile, the malleability of the entire piece depending on that of the separate grains, which are drawn out into fibres; the strength of fibrous iron depending on the fact that, like the individual hemp-fibres in a rope, the fibres lie with their ends in various sections. The microscope shows, further, that none of these wires or fibres is directly connected with its neighbours, either in a longitudinal or lateral direction. In fact each fibre may, by careful etching, be picked out like those of a muscle in the human body. The paper treats also of the constitution of individual iron crystals and of welding. The general result of the analysis shows that the strength of a finished piece of iron depends on the sectional area of the mass of iron it contains, the slag inclusions in weld-iron and blow-holes in ingot-iron being deducted.

It was announced that the autumn meeting of the Institute would be held at Glasgow.

SUNLIGHT AND THE EARTH'S ATMOSPHERE¹

II.

WE have been compared to creatures living at the bottom of the sea who frame their deceptive traditional notions of what the sun is like from the feeble changed rays which sift down to them. Though such creatures could not rise to the surface, they might swim up towards it, and if these rays grew hotter, brighter, and bluer as they ascended, it would be almost within the capacity of a fish's mind to guess that they are still brighter and bluer at the top.

Since we children of the earth, while dwelling on it, are always at the bottom of a sea, though of another sort, the most direct method of proof I spoke of, is merely to goup as far as we can and observe what happens, though as we are men, and not fishes, something more may fairly be expected of our intelligence than of theirs.

We will not only guess, but measure and reason, and in par-

¹ Lecture delivered at the Royal Institution, April 17, 1885, by S. P. Langley. Communicated by the author. Continued from p. 20.

ticular we will first, while still at the bottom of the mountain, draw the light and heat out into a spectrum, and analyse every part of it by some method that will enable us to explore the invisible as well as record the visible. Then we will ascend many miles into the air, meeting the rays on the way down, before the sifting process has done its whole work, and there analyse the light all over again, so as to be able to learn the different proportions in which the different rays have been absorbed, and, by studying the action on each separate ray, to prove the state of things which must have existed before this sifting—this selective absorption—began.

It may seem at first that we cannot ascend far enough to do much good, since the surface of our aerial ocean is hundreds of miles overhead; but we must remember that the air grows thinner as we ascend, the lower atmosphere being so much denser, that about one-half the whole substance or mass of it lies within the first four miles, which is a less height than the tops of some mountains. Every high mountain, however, will not do, for ours must not only be very high, but very steep, so that the station we choose at the bottom may be almost under the station we are afterwards to occupy at the top.

Besides we are not going to climb a lofty lonely summit like tourists to spend an hour, but to spend weeks; so that we must have fire and shelter, and above all we must have dry air to get clear skies. First I thought of the Peak of Teneriffe, but afterwards some point in the territories of the United States seemed preferable, particularly as the Government offered to give the Expedition, through the Signal Service, and under the direction of its head, General Hazen, material help in transportation and a military escort, if needed, any where in its own dominions. No summit in the eastern part of the United States rises much over 7000 feet, and though the great Rocky Mountains reach double this, their tops are the home of fog and mist, so that the desired conditions, if met at all, could only be found on the other side of the Continent in Southern California, where the summits of the Sierra Nevadas rise precipitously out of the dry air of the great wastes in lonely peaks, which look eastward down from a height of nearly 15,000 feet upon the desert lands.

This remote region was, at the time I speak of, almost unexplored, and its highest peak, Mount Whitney, had been but once or twice ascended, but was represented to be all we desired could we once climb it. As there was great doubt whether our apparatus, weighing several thousand pounds, could possibly be taken to the top, and we had to travel 3000 miles even to get where the chief difficulties would begin, and make a desert journey of 150 miles after leaving the cars, it may be asked why we committed ourselves to such an immense journey to face such unknown risks of failure. The answer must be that mountains of easy ascent and 15,000 feet high are not to be found at our doors, and that these risks were involved in the nature of our novel experiment, so that we started out from no love of mere adventure, but from necessity, much into the unknown. The liberality of a citizen of Pittsburgh, to whose encouragement the enterprise was due, had furnished the costly and delicate apparatus for the expedition, and that of the trans-continental railroads, enabled us to take this precious freight along in a private car, which carried a kitchen, a steward, a cook, and an ample larder besides.

In this we crossed the entire continent from ocean to ocean, stopped at San Francisco for the military escort, went 300 miles south so as to get below the mountains, and then turned eastward again on to the desert, with the Sierras to the north of us, after a journey which would have been unalloyed pleasure except for the anticipation of what was coming as soon as we left our car. I do not indeed know that one feels the triumphs of civilisation over the opposing forces of Nature anywhere more than by the sharp contrasts which the marvellous luxury of recent railroad accommodation gives to the life of the desert. When one is in the centre of one of the great barren regions of the globe, and, after looking out from the windows of the flying train on its scorched wastes for lonely leagues of habitless desolation, turns to his well-furnished dinner-table, and the fruit and ices of his desert, he need not envy the heroes of Oriental story who were carried across dreadful solitudes in a single night on the backs of flying genii. Ours brought us over 3000 miles to the Mojave desert. It was growing hotter and hotter when the train stopped in the midst of vast sandwastes a little after midnight. Roused from our sleep, we stepped on to the brown sand and saw our luxurious car roll away in the distance, experiencing a transition from the conditions of civilisation to those almost of barbarism, as sharp as could well be imagined. We

commenced our slow toil northward with a thermometer at 110° in the shade, if any shade there be in the shadeless desert, which seemed to be chiefly inhabited by rattlesnakes of an ashen gray colour, and a peculiarly venomous bite. There is no water save at the rarest intervals, and the soil at a distance seems as though strewed with sheets of salt, which aids the elusive show of the mirage. These are, in fact, the ancient beds of dried-up salt lakes or dead seas, some of them being below the level of the ocean; and such a one on our right, though only about twenty miles wide, has earned the name of "Death Valley," from the number of human beings who have perished in it. Formerly an emigrant train, when emigrants crossed the Continent in caravans, had passed through the great Arizona deserts in safety until after their half-year's journey, their eyes were gladdened by the snowy peaks of the Sierras looking delusively near. The goal of their long toil seemed before them; only this one more valley lay between, and into this they descended, thinking to cross it in a day—but they never crossed it. Afterwards the long line of wagons was found with the skeletons of the animals in the harness, and by them those of men, women, and little children dead of thirst, and some relics of the tragedy remained at the time of our journey. I cite this as an indirect evidence of the phenomenal dryness of the region—a dryness which, so far, served our object, which was, in part, to get rid as much as possible of that water-vapour which is so well known to be a powerful absorber of the solar heat.

Everything has an end, and so had that journey, which finally brought us to the goal of our long travel, at the foot of the highest peak of the Sierras, Mount Whitney, which rose above us in tremendous precipices, that looked hopelessly insurmountable and wonderfully near. The whole savage mountain region in its slow rises from the west, and its descent to the desert plains in the east, is more like the chain called the Apennines, in the moon, than anything I know on the earth. The summits are jagged peaks like Alpine "needles," looking in the thin air so delusively near, that, coming on such a scene unprepared, one would almost say they were large grey stones a few fields off, with an occasional little white patch on the top, that might be a handkerchief or a sheet of paper dropped there. But the telescope showed that the seeming stones were of the height of many Snowdens piled on one another, and the white patches occasional snow-fields, looking how invitingly cool, from the torrid heat of the desert, where we were encamped by a little rivulet that ran down from some unseen ice-lake in that upper air. Here we pitched our tents and fell to work (for you remember we must have two stations, a low and a high one, to compare the results), and here we laboured three weeks in almost intolerable heat, the instruments having to be constantly swept clear of the red desert dust which the hot wind brought. Close by these tents a thermometer covered by a single sheet of glass, and surrounded by wool, rose to 237° in the sun, and sometimes in the tent, which was darkened for the study of separate rays, the heat was absolutely beyond human endurance. Finally, our apparatus was taken apart and packed in small pieces on the backs of mules, who were to carry it by a ten days' journey through the mountains to the other side of the rocky wall which, though only ten or twelve miles distant, arose miles above our heads; and, leaving these mule trains to go with the escort by this longer route, I started with a guide by a nearer way to those white gleams in the upper skies, that had daily tantalised us below in the desert with suggestions of delicious, unattainable cold. That desert sun had tanned our faces to a leather-like brown, and the change to the cooler air as we ascended was at first delightful. At an altitude of 5000 feet we came to a wretched band of nearly naked savages, crouched around their camp-fire, and at 6000 found the first scattered trees; and here the feeble suggestion of a path stopped, and we descended a ravine to the bed of a mountain stream, up which we forced our way, cutting through the fallen trees with an axe, fighting for every foot of advance, and finally passing what seemed impassable. It was interesting to speculate as to the fate of our siderostat mirrors and other precious freight, now somewhere on a similar road, but quite useless. We were committed now, and had to make the best of it—and, besides, I had begun to have my attention directed to a more personal subject. This was, that the colder it grew the more the sun burnt the skin—quite literally burnt, I may say, so that by the end of the third day my face and hands, case-hardened, as I thought, in the desert, began to look as if they had been seared with red-hot irons, here in the cold where the thermometer had fallen to freezing at night; and still as we ascended the paradoxical effect

increased: the colder it grew about us, the hotter the sun blazed above.

We have all heard probably of this curious effect of burning in the midst of cold, and some of us may have experienced it in the Alps, where it may be aided by reflection from the snow, which we did not have about us at any time except in scattered patches, but here by the end of the fourth day my face was scarcely recognisable, and it almost seemed as though sunbeams up here were different things, and contained something which the air filters out before they reach us in our customary abodes. Radiation here is increased by the absence of water vapour too, and on the whole this intimate personal experience fell in almost too well with our anticipations that the air is an even more elaborate trap to catch the sunbeams than had been surmised, and that this effect of selective absorption and radiation was intimately connected with that change of the primal energies and primal colour of the sun which we had climbed towards it to study.

On the fourth day, after break-neck ascents and descents, we finally ascended by a ravine, down which leaped a cataract, till, at nightfall, we reached our upper camp, which was pitched by a little lake, one of the sources of the water-fall, at a height of about 12,000 feet, but where we seemed in the bottom of a valley, nearly surrounded as we were by an amphitheatre of rocky walls which rose perpendicularly to the height of Gibraltar from the sea, and cut off all view of the desert below or even of the peak above us.

The air was wonderfully clear, so that the sun set in a yellow rather than an orange sky, which was reflected in the little ice-rimmed lakes and from occasional snow-fields on the distant waste of lonely mountain summits on the west.

The mule train sent off before by another route, had not arrived when we got to the mountain camp, and we realised that we were far from the appliances of civilisation by our inability to learn about our chief apparatus, for here, without post or telegraph, we were as completely cut off from all knowledge of what might be going on with it in the next mountain ravine as a ship at sea is of the fate of a vessel that sailed before from the same port. During the enforced idleness we ascended the peak nearly 3000 feet above us, with our lighter apparatus, leaving the question of the ultimate use of the heavy ones to be settled later. There seemed little prospect of carrying it up, as we climbed where the granite walls had been split by the earthquakes, letting a stream of great rocks, like a stone river, flow down through the interstices by which we ascended, and, in fact, the heavier apparatus was not carried above the mountain camp.

The view from the very summit was over numberless peaks on the west to an horizon fifty miles away, of unknown mountain-tops, for, with the exception of the vast ridge of Mount Tyndall, and one or two less conspicuous ones, these summits are not known to fame, and, wonderful as the view may be, all the charm of association with human interest which we find in the mountain landscape of older lands is here lacking.

It was impossible not to be impressed with the savage solitude of this desert of the upper air, and our remoteness from man and his works, but I turned to the study of the special things connected with my mission. Down far below the air seemed filled with reddish dust that looked like an ocean. This dust is really present everywhere (I have found it in the clear air of Etna), and though we do not realise its presence in looking up through it, to one who looks down on it, the dwellers on the earth seem indeed like creatures at the bottom of a troubled ocean. We had certainly risen towards the surface, for about us the air was of exquisite purity, and above us the sky was of such a deep violet blue, as I have never seen in Egypt or Sicily, and yet even this was not absolutely pure, for separately invisible, the existence of fine particles could yet be inferred from their action on the light near the sun's edge, so that even here we had not got absolutely above that dust shell which seems to encircle our whole planet. But we certainly felt ourselves not only in an upper, but a different region. We were on the ridge of the continent, and the winds which tore by had little in common with the air below, and were bearing past us (according to the geologists) dust which had once formed part of the soil of China, and been carried across the Pacific Ocean; for here we were lifted into the great encircling currents of the globe, and, "near to the sun in lonely lands," were in the right conditions to study the differences between his rays at the surface and at the bottom of that turbid sea where we had left the rest of mankind. We descended the peak and hailed with joy the first arrival of our mule trains with the requisite apparatus at the

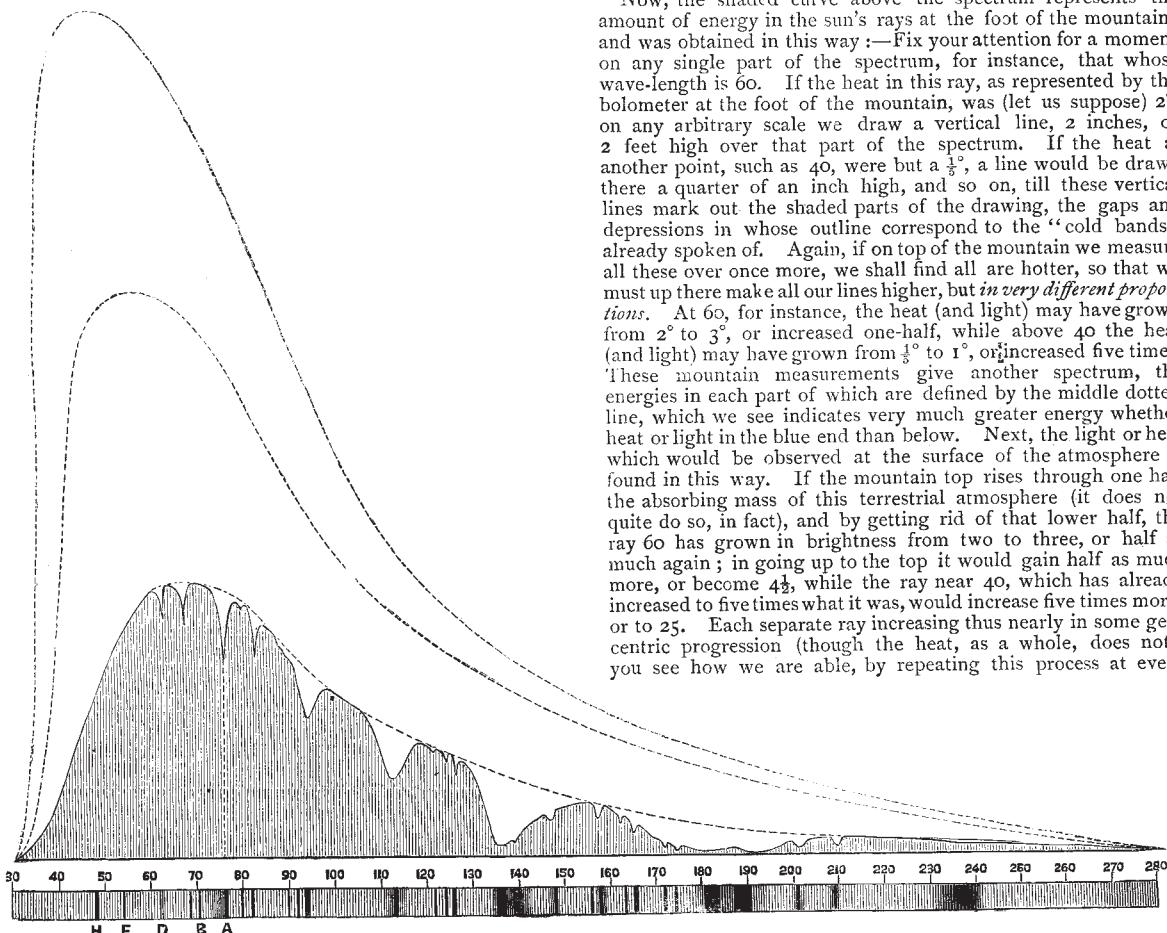
mountain camp, and found that it had suffered less than might be expected, considering the pathless character of the wilderness. We went to work to build piers and mount telescopes and siderostats, in the scene shown by the next illustration on the screen, taken from a sketch of my own, where these rocks in the immediate foreground rise to thrice the height of St. Paul's. We suffered from cold (the ice forming 3 inches deep in the tents at night) and from mountain sickness, but we were too busy to pay much attention to bodily comfort, and worked with desperate energy to utilise the remaining autumn days, which were all too short.

Here, as below, the sunlight entered a darkened tent, and was spread into a spectrum, which was explored throughout by the bolometer, measuring, on the same separate rays which we had studied below in the desert, all of which were different up here, all having grown stronger, but in very different propor-

tions. On the screen is the spectrum as seen in the desert, drawn on a conventional scale, neither prismatic nor normal, but such that the intensity of the energy shall be the same in each part, as it is represented here by these equal perpendiculars in every colour. Fix your attention on these three as types, and you will see better what we found on the mountain, and what we inferred as to the state of things still higher up, at the surface of the aerial sea.

You will obtain, perhaps, a clearer idea, however, from the following statement, where I use, not the exact figures used in calculation, but round numbers, to illustrate the process employed. I may premise that the visible spectrum extends from H (in the extreme blue) to A (in the deepest red), or from near 40 (the ray of forty one hundredthousandths of a millimetre in wave-length) to near 80. All below 80, to the right, is the invisible infra-red spectrum.

Now, the shaded curve above the spectrum represents the amount of energy in the sun's rays at the foot of the mountain, and was obtained in this way:—Fix your attention for a moment on any single part of the spectrum, for instance, that whose wave-length is 60. If the heat in this ray, as represented by the bolometer at the foot of the mountain, was (let us suppose) 2° , on any arbitrary scale we draw a vertical line, 2 inches, or 2 feet high over that part of the spectrum. If the heat at another point, such as 40, were but a $\frac{1}{3}$, a line would be drawn there a quarter of an inch high, and so on, till these vertical lines mark out the shaded parts of the drawing, the gaps and depressions in whose outline correspond to the "cold bands" already spoken of. Again, if on top of the mountain we measure all these over once more, we shall find all are hotter, so that we must up there make all our lines higher, but *in very different proportions*. At 60, for instance, the heat (and light) may have grown from 2° to 3° , or increased one-half, while above 40 the heat (and light) may have grown from $\frac{1}{3}$ to 1° , or increased five times. These mountain measurements give another spectrum, the energies in each part of which are defined by the middle dotted line, which we see indicates very much greater energy whether heat or light in the blue end than below. Next, the light or heat which would be observed at the surface of the atmosphere is found in this way. If the mountain top rises through one half the absorbing mass of this terrestrial atmosphere (it does not quite do so, in fact), and by getting rid of that lower half, the ray 60 has grown in brightness from two to three, or half as much again; in going up to the top it would gain half as much more, or become $4\frac{1}{2}$, while the ray near 40, which has already increased to five times what it was, would increase five times more, or to 25. Each separate ray increasing thus nearly in some geometric progression (though the heat, as a whole, does not), you see how we are able, by repeating this process at every



Distribution of Solar Energy at Sea-level and at various Altitudes.

point, to build up our outer or highest curve, which represents the light and heat at the surface of the atmosphere. These have grown out of all proportion at the blue end, as you see by the outer dotted curve, and now we have attained, by actual measurement, that evidence which we sought, and by thus reproducing the spectrum outside the atmosphere, and then recombining the colours by like methods to those you have seen on the screen, we finally get the true colour of the sun, which tends, broadly speaking, to blue.

It is so seldom that the physical investigator meets any novel fact quite unawares, or finds anything except that in the field where he is seeking, that he must count it an unusual experience to come unexpectedly on even the smallest discovery. This experience I had on one of the last days of work on the spectrum on the mountain. I was engaged in exploring that great invisible heat region, still but so partially known, or, rather, I was mapping in that great "dark continent" of the spectrum,

and by the aid of the exquisite sky and the new instrument (the bolometer) found I could carry the survey further than any had been before. I substituted the prism for the grating, and measured on in that unknown region till I had passed the Ultima Thule of previous travellers, and finally came to what seemed the very end of the invisible heat spectrum beyond what had previously been known. This was in itself a return for much trouble, and I was about rising from my task when it occurred to me to advance the bolometer still farther, and I shall not forget the surprise and emotion with which I found new and yet unrecognised regions below,—a new invisible spectrum beyond the farthest limits of the old one.

I will anticipate here by saying that after we got down to lower earth again the explorations and mapping of this new region was continued. The amount of solar energy included in this new extension of the invisible region is much less than that of the visible spectrum, while its length upon the wave-length

scale is equal to all that previously known, visible and invisible, as you will see better by this view, leaving the same thing on the normal as well as the prismatic scale. If it be asked which of these is correct, the answer is "both of them." Both rightly interpreted mean just the same thing, but in the lower one we can more conveniently compare the ground of the researches of others with these. These great gaps I was at first in doubt about, but more recent researches at Alleghany make it probable that they are caused by absorption in our own atmosphere, and not in that of the sun.

We would gladly have stayed longer, in spite of physical discomfort, but the formidable descent and the ensuing desert journey were before us, and certainly the reign of perpetual winter around us grew as hard to bear as the heats of the desert summer had been. On September 10 we sent our instruments and the escort back by the former route, and, ourselves unencumbered, started on the adventurous descent of the eastern precipices by a downward climb, which, if successful, would carry us to the plains in a single day. I at least shall never forget that day, nor the scenery of more than Alpine grandeur which we passed in our descent, after first climbing by frozen lakes in the northern shadow of the great peak, till we crossed the eastern ridges, through a door so narrow that only one could pass it at a time, by clinging with hands and feet as he swung round the shoulder of the rocks—to find that he had passed in a single minute from the view of winter to summer, the prospect of the snowy peaks behind shut out, and instantly exchanged for that below of the glowing valley and the little oasis where the tents of the lower camp were still pitched, the tents themselves invisible, but the oasis looking like a green scarf dropped on the broad floor of the desert. We climbed still downward by scenery unique in my recollection. This view of the ravine on the screen is little more than a memorandum made by one of the party in a few minutes' halt part-way down, as we followed the ice-stream between the tremendous walls of the defile which rose 2000 feet, and between which we still descended, till, toward night, the ice-brook had grown into a mountain torrent, and, looking up the long vista of our day's descent, we saw it terminated by the Peak of Whitney, once more lonely in the fading light of the upper sky.

This site, in some respects unequalled for a physical observatory, is likely, I am glad to say, to be utilised, the President of the United States having, on the proper representation of its value to science, ordered the reservation for such purposes of an area of 100 square miles about and inclusive of Mount Whitney.

There is little more to add about the journey back to civilisation, where we began to gather the results of our observation, and to reduce them—to smelt, so to speak, the metal from the ore we had brought home—a slow but necessary process, which has occupied a large part of two years.

The results stated in the broadest way mean that the sun is blue—but mean a great deal more than that; this blueness in itself being perhaps a curious fact only, but in what it implies, of practical moment.

We deduce in connection with it a new value of the solar heat, so far altering the old estimates that we now find it capable of melting a shell of ice sixty yards thick annually over the whole earth, or, what may seem more intelligible on its practical bearings, of exerting over one horse power for each square yard of the normally exposed surface. We have studied the distribution of this heat in a spectrum whose limits on the normal scale our explorations have carried to an extent of rather more than twice what was previously known, and we have found that the total loss by absorption from atmosphere is nearly double what has been heretofore supposed.

We have found it probable that the human race owes its existence and preservation even more to the heat-storing action of the atmosphere than has been believed.

The direct determination of the effect of water-vapour in this did not come within our scope; but that the importance of the blanketing action of our atmospheric constituents has been in no way overstated, may be inferred when I add that we have found by our experiments that if the planet were allowed to radiate freely into space without any protecting veil, its sunlit surface would probably fall, even in the tropics, below the temperature of freezing mercury.

I will not go on enumerating the results of these investigations, but they all flow from the fact, which they in turn confirm, that this apparently limpid sea above our heads, and about us,

is carrying on a wonderfully intricate work on the sunbeam, and on the heat returned from the soil, picking out selected parts in hundreds of places, sorting out incessantly at a task which would keep the sorting demons of Maxwell busy, and as one result, changing the sunbeam on its way down to us in the way we have seen.

I have alluded to the practical utilities of these researches, but practical or not, I hope we may feel that such facts as we have been considering about sunlight and the earth's atmosphere may be stones useful in the future edifice of science, and that if not in our own hands then in those of others, when our day is over, they may find the best justification for the trouble of their search, in the fact that they prove of some use to man.

May I add an expression of my personal gratification in the opportunity with which you have honoured me of bringing these researches before the Royal Institution, and of my thanks for the kindness with which you have associated yourselves for an hour, in retrospect at least, with that climb toward the stars which we have made together, to find, from light in its fullness, what unsuspected agencies are at work to produce for us the light of common day.

ZOOLOGICAL RESEARCH¹

THE *Vettor Pisani* is soon expected in our port, on her return from a long voyage of no little scientific importance. We think we cannot better hail her arrival than by publishing that portion of Prof. Dohrn's report in which he speaks of the scientific mission fulfilled by this vessel—a mission which, besides meeting with a success far surpassing the highest expectations, has redounded not a little to the benefit of our "Stazione Zoologica."

The time has now arrived, writes the illustrious Professor, for me to speak of an event which took place towards the end of 1881, and which has since borne no inconsiderable fruit. And this, in its turn, takes me back to a conversation which I had in 1878 with the Italian Minister of Marine. I had already proposed that, instead of sending out a young naturalist on board the frigates which sail around the world, a young naval officer should be sent to the "Stazione Zoologica," where, in about four months, he might pick up so much knowledge as would enable him to collect and preserve specimens of marine animals. Owing to a change in the Ministry, my proposition, though accepted in the main, was forgotten; and I only succeeded in getting it put into execution in 1881.

On December 27, 1881, a young naval lieutenant, Signor Gaetano Chierchia, a Neapolitan by birth, introduced himself to me with these words: "I have been sent by the Ministry to learn under your direction at the 'Stazione Zoologica' how to collect and preserve specimens of marine animals. I present myself accordingly, and beg to be allowed to begin work at once." These few words, modest, yet full of energy, made a deep impression on me; for they not only marked the beginning of a new epoch in the active life of the Zoological Station, but also promised a more intimate connection between it and the officers of the Italian navy—an intimacy to which I had looked forward from the very day in which I conceived the idea of the future floating Zoological Station.

With the same modest energy which characterised his first interview with me, Signor Chierchia continued for four months his studies under the special direction of the Curator, Salvatore Lobianco; and all the employes and naturalists of the Zoological Station were astounded at the rapid progress he made in a field so entirely new to him. And when the moment came for establishing my laboratory on board the corvette *Vettor Pisani* (which came most appropriately to Naples), and there had been put on board all the fishing apparatus, chemical reagents, alcohol, glass vessels, &c., we accompanied him as a dear friend, and looked forward to results which should mark a distinct advance in the culture of our science. And our expectations, far from being disappointed, were widely surpassed. After only five months there arrived the first consignment—the product of deep-sea work, of dredging and coast-fishery along the shores of Gibraltar, Brazil, and Montevideo. The whole collection was in excellent preservation, carefully labelled and packed, and accompanied by a minute report as to the place and circumstances of each find. And I do not for a moment hesitate to affirm that never has so important a collection of oceanic

¹ From the *Pungolo*, April 23, 1885. Naples, Italy.